Access to Community Resources in Disadvantaged Areas and its Impact on Hospital Readmission in Cardiovascular Disease Patients

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ABSTRACT

Community Resources and Hospital Readmission

Background: Cardiovascular disease (CVD) is one of the conditions that contribute most to the number of patient readmissions in the United States. Hospital and patient characteristics influence rehospitalization; in addition to major risk factors such as high blood pressure or high cholesterol, other factors such as age, ethnicity and socioeconomic status are associated with hospital readmission for CVD patients.

Objective: The purpose of this study is to examine whether differences in community-level resources in disadvantaged neighborhoods is associated with 30-day hospital readmissions in patients with CVD.

Design: Retrospective cohort study.

Setting: Durham County and Granville County in the state of North Carolina.

Patients: Patients from Durham County and Granville County admitted for CVD to Duke University Hospital and Durham Regional Hospital, from January 1, 2005 to January 1, 2015 (n = 1,033).

Results: Overall, there was no significant bivariate difference of 30 day readmission for CVD between Durham and Granville Counties for the 10 year period. However the results from the logistic regression models estimating the factors associated with 30-day

readmission when area-level factors are held constant suggest that patients from Granville county are significantly more likely to be readmitted than patients from Durham county (OR=1.28; 95% CI, 1.15-1.43).

Conclusions: This study suggests that living in the proximity to community resources play an important role in patients' health and affects readmission within 30-days of initial discharge.

Keywords:

Cardiovascular disease, Hospital readmission, Socioeconomic status, disadvantage area, and Community resources.

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LIST OF ABBREVIATIONS

ACC	American College of Cardiology
ACS	American Community Survey
AHA	The American Heart Association
BMI	Body Mass Index
CI	Confidence Interval
CVD	Cardiovascular Disease
DEDUCE	Duke Enterprise Data Unified Content Explorer
DRG	Diagnosis Related Group
DRH	Duke Regional Hospital
DUH	Duke University Hospital
HRSA	Health Resources Services Administration
ICD-9	International Classification of Diseases 9th edition
IRB	Institutional Review Board
MedPAC	Medicare Payment Advisory Commission
MRN	Medical Record Number
NC	North Carolina
OMB	Office of Management and Budget's
OR	Odd's Ratio
PADC	Project Access to Durham County
PDE	Post-Discharge Environment
SES	Socioeconomic Status

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Background

Cardiovascular Disease

Cardiovascular disease (CVD) is among the leading causes of disability and death in the United States.[1,2] Cardiovascular diseases affect the heart and blood vessels, and include: coronary heart disease, congestive heart failure, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolisms, among others.[1] More than 2 million elderly people in the United States are estimated to have heart failure; in addition, about 400,000 people will be newly diagnosed with the condition every year.[3] Cardiovascular-related illnesses are responsible for approximately 17% of U.S. national health care costs.[2] Direct costs of CVD are projected to increase from $272.5 billion on 2010 to $818.1 billion in 2030 the United States.[2] Indirect costs are projected to increase from 171.1 billion in 2010 to 275.8 billion in 2030 in the United States.[2]

In the last 10 years appropriate interventions that target risk factors have proven to be an effective way to prevent CVD[4]. The American Heart Association (AHA) and the American College of Cardiology (ACC) classifies the risk factors into major independent risk factors and other factors, the major independent risk factors are those that can produce CVD if left untreated, smoking, high blood pressure, elevated serum total (and LDL) cholesterol, low serum HDL cholesterol, diabetes, and advancing age.[4] Other factors are those that influence the independent risk factors causing a negative effect, first are the conditional risk factors, or predisposing factors such as elevated serum triglycerides, second are the conditional risk factors obesity, physical inactivity, family history, genetics, and race/ethnicity.[4] In the United States the most used method to

predict risk is the Framingham risk score, the first estimation system and most used method, estimates 10 year risk for CVD in asymptomatic patients[5] using a mathematical model and multivariable risk formulations to predict CVD risk, [6] the goal is to identify risk more precisely and determine the intensity of preventive measures.[4] it is also noted that when combined risk factors can put an individual at a higher risk of developing CVD, for example a patient with family history of early CVD, with an elevated body mass index (BMI) and with a sedentary lifestyle has a higher risk of developing CVD if there are no interventions. [5] In the United States about half of the population has one the three major risks for developing CVD, high blood pressure, high cholesterol or smoke, men and women are at equal risk of developing CVD in their lifetime, in addition CVD is the leading cause of death for white and black non-Hispanics and the second leading cause of death for Hispanics in the United States.[7]

Hospital Readmissions in Cardiovascular Patients

Cardiovascular disease, as noted by Jweinatt (2010), has been identified as one of the conditions that contribute most to the number of patient readmissions in the United States. Among cardiovascular conditions, heart failure is the leading cause of hospitalization among adults 65 years and older in the United States.[8]The rate of readmission of patients with heart failure within 6 months is 50%, [9] Krumholz and colleagues (2009) found the rate of readmission to the hospital within 30 days of discharge was approximately 24%, as cited by Desai and Stevenson.[8] In 2011, heart failure was the top condition for hospital 30-day readmissions for Medicare patients 65 years and older—the total cost was 1.7 billion.[10] Hospital readmissions are considered by health care leaders, providers, and the public as potentially preventable, costly, and often

an indicator of quality of care.[11,12] The Medicare Payment Advisory Commission (MedPAC) reported that the cost for rehospitalizations that could have been prevented is $12 billion per year.[13]

Although improvement in early diagnosis, treatments, and health outcomes continue, readmission rates continue to be high. Two key policies have brought the issue of hospital readmission to national attention, first in 2009 the US Center for Medicare and Medicaid Services started to report to the public all-cause readmission rates following hospitalization for heart failure, then in 2010 the Patient Protection and Affordable Care Act set financial penalties for hospitals that had the highest readmission rates within the first 30 days after discharge.[8]

These policies are important because they shift the paradigm, holding hospitals accountable for patient's health outcomes after discharge,[14] but most importantly, it focuses attention on the importance of understanding the causes for hospital readmission to be able to create interventions that can modify these factors.

Socioeconomic Deprivation

Risks for hospital readmission after discharge largely depend on a constellation of hospital and patient characteristics. Patient characteristics have been identified by measures of disease severity, demographic background, post-discharge environment (PDE), and socioeconomic status (SES).[11] Socioeconomic factors include income, education, and social connectedness,[15] Post-discharge environmental factors include patient household characteristics and the caregiving setting following discharge.[16] Studies have shown that SES and PDE factors such as having low SES, living alone or lacking social support can impact health care utilization. For early readmissions, 76% of

preventable readmissions for heart failure were associated with SES and PDE factors such as lack of follow up and social support.[16] Furthermore studies have linked high rates of hospitalization and readmission to patients with heart failure who lack employment, have low income, and live in disadvantaged areas.[17]

For the purposes of this study the focus is on how area resources are associated with hospital readmission for CVD patients. The concept is already used for predicting CVD.[5] First, the Framingham score a useful method to predict CVD on diverse populations[6] and effective tool to identify and communicate risk to individual patients; [5] studies have shown however that the Framingham risk score underestimates socioeconomic deprivation as a risk factor.[25] Consequently, newer risk estimation systems include social deprivation as risk factors. For example, ASSIGN, designed to estimate CVD risk in Scotland, includes additional information such as family history and social deprivation, where measures of social deprivation are linked to postal codes in Scotland giving this system the ability to locate the risk by geographic area. QRISK is another measurement system that pulls data from general data bases and also includes social deprivation as an area measure.[18]

Area resources as risk factors for readmission are not easy to identify because they are not risks that are assigned to patients when admitted to the hospital. In addition, socioeconomic factors are not recorded in patients' medical records nor used as a measure in hospitals' medical record system reports.[19] The patient place of residence is in fact a factor that affects hospital readmission because patients that are vulnerable are dependent on their neighborhood resources to fulfill some of their needs: access to food, transportation, education, and health care.[19] Fonarow and colleagues (2008) documented

that socioeconomic factors affect patient compliance with medication plans, adherence, follow up and self-monitoring as cited by Desai and Stevenson.[8]

Area resources can be used to study patient risk for readmission by linking the patient address to Census data of that particular area.[20]

Description of the hypothesis being tested

The purpose of this retrospective study is to examine whether differences in community-level resources in disadvantaged areas is associated with hospital readmissions in patients with CVD. The study analyzes the association between two disadvantage areas in North Carolina in relation to 30 day hospital readmissions for patients admitted for a CVD-related diagnosis.

Methods

Study Population and Data Sources

The retrospective study identifies two comparably disadvantaged areas defined by zip codes. The two areas were selected based on geographic proximity and by using three economic indicators: median household income, insurance status, and percentage of population below the poverty level from the American Community Survey (ACS) in the US Census Bureau. The first area selected was Durham County NC, and after reviewing the economic indicators it was decided to select five zip codes as the most disadvantage areas: 27701, 27703, 27704, 27705, and 27707 (see Table 1 and Figure 1). The same process was followed with the comparison group of Granville County, six zip codes were identified as the most disadvantage areas: 27507, 27509, 27522, 27565, 27581, and 25582 (see Table 1 and Figure 1). The study chose Granville County as a control group after carefully reviewing general demographics characteristics for seven counties in

North Carolina that do not have a big urban area, the counties selected were: Alamance, Granville, Randolph, Johnston, Nash, Warren, Person and Vance. Data was collected for these counties using the American Fact Finder tool from the US Census Bureau (http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml). The statistics collected for each county were: population count, number of people 65 years and older, percent of white people, percent of African Americans, percent of Hispanic, median household income, percent of people with no insurance coverage and percent of people below the poverty level. Granville County was the most similar in area level characteristics to the study area of interest Durham County.

Health resources for each zip code were researched to understand the proximity to health care services and community resources for both counties, using the Health Resources Services Administration (HRSA) Data Warehouse (http://datawarehouse.hrsa.gov/). I measured proximity of resources in miles and divided into one of three groups: resources within 5 miles, 10 miles and 15 miles. Durham County community resources were found to be within five miles of each zip code, while Granville County community resources were found to be within 15 miles from each zip code. Table 2 provides a comparison of the number of community resources between the two counties. The resources listed are located between 0-10 miles distance from each zip code; using this summary, the average number of resources for Durham County is 9.8 and for Granville County it is only 0.3. Durham County resources are not only numerically greater than Granville but they are diverse in terms of care: primary care, behavioral health, and wellness centers. Once the geographic areas for the study and its comparison

group were summarized by economic indicators and proximity to community resources, the definition for readmission was the next step.

Readmission is defined as a subsequent hospital admission within 30 days after discharge from the index admission for a cardiovascular-related diagnosis. This included all patients admitted to Duke University Hospital (DUH) and Duke Regional Hospital (DRH) over the past 10 years. Cardiovascular diagnoses were defined based on the International Classification of Diseases 9th edition (ICD-9) admission codes 390-438. Patients with more than 20 encounters (n=6 patients had between 21 and 64 encounters) were omitted to minimize possible bias due to over-representation of these outlier data.

The data used for the study were clinical data of all eligible subjects who were admitted to DUH or DRH for the treatment of cardiovascular-related illnesses and those with an address recorded in their medical records with a matching zip code from Durham County or Granville County. Clinical data was stored at the organizational data warehouse at Duke University Health System; these data were extracted using the Duke Enterprise Data Unified Content Explorer (DEDUCE). DEDUCE is a self-service research portal that combines data from clinical and billing systems from across these two institutions, the produced data is both granular and cumulative.[21] After obtaining Institutional Review Board (IRB) approval from Duke University and The University of North Carolina at Chapel Hill, this study obtained data from January 1, 2005 to January 1, 2015. Data elements from three sources were used to build a cohort filter: patient demographics, patient geography and patient hospital encounters (see Table 3). The patient demographics elements included Duke Medical Record Number (MRN), date of birth, gender, race (categorized as white, black or other), ethnic group, and death

indicator; patient geography elements included, city, primary postal code, and county; and patient hospital encounters elements included, hospital, admission date, discharge date, payor group, age at arrival in years, Diagnosis Related Group (DRG) code, ICD9 diagnosis code, diagnosis name, diagnosis date and diagnosis type description.

The resulting data sample contained patient encounters for patients admitted to DUH or DRH with a CVD diagnosis during the noted 10 year period. The study excluded patients under 18 years old and patients with no zip codes reported. Patients were identified by MRN, and encounters counted were those with the specific CVD ICD9 codes.

Analyses

The study used Stata analytic software version 14.0 (StataCorp) to generate descriptive statistics and conduct multivariate regression analyses. The initial stage of analyses (Aim 1) examined the unadjusted distributions of patients to characterize their background demographics, hospital admissions, and several area-level factors characterizing the residential area: percent of elderly adults, percent of nonwhite adults, household income, percent of patients below poverty level, and percent of patients with no health insurance. Differences between Durham and Granville Counties were assessed using chi-square tests (for categorical variables) and Kruskal-Wallis tests (for continuous variables). The second stage of analysis (Aim 2) used multivariate methods to identify the factors associated with 30-day readmissions. Logistic regression models were estimated in several steps to demonstrate first whether Granville County had higher rates of readmission than Durham County (Model 1) written as: $logit(OR) = \beta_0 + \beta_1 * \text{county}$. Second

whether background demographics play a role in the associations (Model 2) written as: $logit(OR) = \beta_0 + \beta_1*county + \beta_2*age + \beta_3*male + \beta_4*nonwhite$. Third whether area-level characteristics (Model 3) play a role in the associations $logit(OR) = \beta_0 + \beta_1*county + \beta_2*age + \beta_3*male + \beta_4*nonwhite + \beta_5*pct\_nonwhite + \beta_6*HHincome$. Preliminary analyses included all area-level factors; however, multicollinearity and model over-identification (related to sample size/power) prohibited the inclusion of each measure. Therefore, the final models only include the statistically significant area-level factors (household income and percent nonwhite race). Results were reported as odds ratios (OR) with 95% confidence intervals (CI). All models also adjusted standard errors for clustering based on hospital of admission (i.e., DUH vs. DRH).

Results

There were 16,383 patient encounters for the Access to Community Resources in Disadvantaged Areas and its Impact on Hospital Readmission in Cardiovascular Disease Patients study. The study identified 3,143 (19%) encounters for patients admitted to either DUH or DRH who had been admitted for a cardiovascular-related condition; 2,873 (91%) hospital encounters were for Durham County patients and 270 (9%) hospital encounters for Granville County patients. The number of encounters corresponded to 1,033 patients admitted for CVD living in Durham County in the areas containing the zip codes 27701, 27703, 27704, 27705, and 27707, and 107 patients living in Granville County in the areas containing the ZIP codes 27509, 27522, 27565, and 27581.

Table 4 shows descriptive information for the 1,033 patients, 38.69% of the total for both counties are male, with significantly more males in Granville County than

Durham County (51.11% vs 37.52%, respectively). Among all patients, 57.05% are non-white race, Durham County have a larger number of non-white race patients than Granville County (60.39% vs 21.48%, respectively). The total percentage of patients admitted to Duke University Hospital is 54.18%, Durham County has more patients admitted than Granville County to this particular hospital (55.48% vs 40.37%, respectively). The total percentage of patients admitted to Duke Regional Hospital is 45.82%, Granville County has more patients admitted than Durham County to this particular hospital (59.63% vs 44.52%, respectively).

Table 4 also displays area-level characteristics using the zip codes combined and then split for each county. The average percent of individuals over 65 years old is 10.21% for both counties combined; Granville county has a larger number of residents over 65 years old in than Durham County (12.33% vs 10.01%, respectively). The total percent of non-white individuals for both counties is 56.16%, Durham County has a significantly larger non-white population than Granville County (57.61% vs 40.64%, respectively). The total percent of individuals for both counties with no health insurance is 17.18%, Durham County has more uninsured individuals than Granville County (17.53% vs 13.46%, respectively). The percent of individuals living below the poverty level as defined by the Office of Management and Budget's (OMB) poverty thresholds is 22.47% for both counties, Durham County has a larger number of individuals living below the poverty level than Granville County (23.10% vs 15.80%, respectively). The average household income for the counties is $42,920, in Durham County the average is $42,510 and in Granville County is $47,260. The percentage of patients with 30-day readmission is 18.20% for the two counties combined (representing a total of 188 patients), Durham

County 18.17% (168 patients) were readmitted within 30 days compared to 18.52% (20 patients)in Granville County. Overall, there was no significant bivariate difference of 30 day readmission for CVD between Durham and Granville Counties based on these data for the noted 10 year period.

Table 5 reports the results from the logistic regression models estimating the factors associated with 30-day readmission in Durham and Granville counties. In Model 1, we see no significant difference in rates of readmission between the two counties. Model 2 includes the individual-level characteristics and further shows no significant differences between Durham and Granville when taking into account differences in age, sex, and race. The final analysis includes the individual- and area-level factors (Model 3) and shows a significant difference in readmission when area-level factors are held constant. Results suggest that patients from Granville county are significantly more likely to be readmitted than patients from Durham county (OR=1.28; 95% CI, 1.15-1.43).

Discussion

These study findings have important implications for the practice of public health because they highlight the importance of socioeconomic factors as predictors for CVD patients' hospital readmission within 30 days and the importance of community resources to compensate for the lack of resources at home, due to low SES or lack of social support. In recent years socioeconomic factors as predictors of health outcomes have gained popularity after newer risk estimation systems such as ASSIGN, which includes social deprivation as a CVD risk factor.[18] There is, however, few studies about the influence and access to community resources and health outcomes. The idea behind this study came

from the observation of the community health resources in Durham County and the question of whether these resources were in fact influencing health in the community. Durham County is a unique area rich in medical resources, the ratio of primary care providers per residents is 1:809 compared to the North Carolina state ratio of 1:1462[22], and Durham County ranks high in the US for Counties considered as "best performing" for clinical care[22]. In addition to a university hospital, Durham County has a network of community health centers that deliver primary care services to the population, Lincoln Community Health center and its satellite clinics Holton, Lyon Park and Walltown, serve low-income and uninsured patients in Durham County. In addition, the partnership with Duke University and the University of North Carolina University at Chapel Hill has given Durham's low-income residents access to resources beyond the clinical setting. They provide home care services such as Just for Us, at home care for the elderly, or Project Access to Durham County (PADC) care coordination for uninsured low income Durham residents in need of specialty health care [22]. The study chose Granville County as a control group after carefully reviewing general demographics characteristics for seven counties in North Carolina that do not have a big urban area, the counties initially selected were: Alamance, Granville, Randolph, Johnston, Nash, Warren, Person and Vance. Data was collected for these counties using the American Fact Finder tool from the US Census Bureau, the statistics collected for each county were: population count, number of people 65 years and older, percent of white people, percent of African Americans, percent of Hispanic, median household income, percent of people with no insurance coverage and percent of people below the poverty level. Granville County was the most similar in area level characteristics to the study area of interest Durham County.

The study findings provide important results to improve health outcomes for CVD patients at a hospital level, community level, and public policy level using a public health practice approach. The study findings suggest that hospitals should consider CVD patients' both their living environment and community support system at the time of admission to the hospital as a quality of care intervention. As documented by Krumholz and colleagues, readmission is costly to the health system and also preventable, [12] in addition obtaining these characteristics may help hospitals to better measure performance when admitting patients with CVD. Understanding patient social and living environment at the time of hospitalization can help create interventions that improve patient quality of care at a hospital level and lower the chances of readmission. This study has shown that hospital medical records systems at DUH and DRH currently do not include data fields that capture patients' risk for rehospitalization other than clinical factors. Registration of SES patient data in addition to clinical data by health care providers can be used to improve quality of care. In addition, statistically analyzed data are valuable to generate a patient profile for CVD patients at risk of readmission. These data can help evaluate projects and interventions for this specific group of patients, and reports derived from the data can also support funding requests of new projects that aim to improve health outcomes.[23]

Recommendations for public policy changes can be made based on evidence found by studies like the one presented, public health practitioners can influence policy decisions because they understand the factors that affect CVD readmission. Policy level interventions such as addressing poverty can create solutions at a neighborhood level regarding housing, education, jobs and public safety. [22] Evidence is important to create

policy, appropriations and laws that will improve health in the community by improving the living space in neighborhoods, such as parks that can foster community engagement. Laws can also help by allocating funding for programs that affect population health, such as smoking cessation and health care management at home. Most importantly public health practitioners need to have the appropriate tools to be strong advocates during the policy making process, such that efforts are undertaken to enhance communities so that people have the appropriate resources within reaching distance when they encounter a major life event such as CVD.

These study findings support the hypothesis that access to community resources are an influential factor for hospital readmission. Community based interventions that aim to improve the transition from hospital to home for CVD patients can impact patients' post discharge conditions and lower their probability of being readmitted. A multidisciplinary disease management approach is proven to decrease readmission rates after discharge.[24] Beyond policy changes, strategic planning is needed to reach the goals of such policies. Effective strategic planning should include government organizations, non-profit organizations, for profit corporations, community coalitions, and other community organizations such that they collaborate to make health services more efficient. Strategic planning includes an examination of the current status and options for improvement or change, it also creates a rational step by step plan to carry on in a systematic way the proposed changes.[23]

The study presented has some limitations. First, to be included in the study patients records had to include a zip code. Therefore, the study results do not include the

homeless population or those patients without a zip code associated with their medical record number. In addition, analysis at a patient level with geographic information as a measure can add inconsistencies to the study by aggregating the characteristics of an area to all individuals within that area, [19] this is true for this study since Durham County has an economically diverse population in a densely populated area. Second, there were no direct measures of area-level resources used in this study; therefore, I remain cautious when interpreting the findings as they relate to the hypothesized influence of differential resources.

Another limitation is that the results of this study may not be generalizable to areas beyond the selected North Carolina Counties. As such, the regional focus of the study may be unique to these counties. However, since the data is consistent with national numbers for CVD readmission, it leads me to believe the results can be widely applicable. Finally the data analysis indicates a difference for 30-day readmissions between Durham County and Granville County 18.17% compared to 18.52%, though not statistically significant. Additional and more comprehensive studies should be made that result in more significant data analysis that supports the hypothesis that CVD patient's access to community resources is a contributing factor to the risk of being readmitted to the hospital. Limitations aside this study has important contributions, the study identified an association between CVD patients' access to community resources and low SES, and the likelihood of being readmitted after hospitalization. Finally, it should be noted that the study results were nationally representative of 30-day readmissions.

Conclusion

Cardiovascular disease in the United States is one of the conditions that contribute the most to hospital readmission, interventions that target the risk factors for CVD are an effective way to prevent the disease, in the last years more complex methods to predict risk factors have been designed, they include not only the major risk factors such as smoking and high blood pressure but also patient low SES, and environment. Despite improvement in preventing CVD, rehospitalization for CVD remains high and it is not only costly to the health system but also an indicator of the quality of care. Studies have shown that living in a disadvantage area with limited community resources is a contributing risk factor for hospital readmission in CVD patients. This study suggests that living in the proximity to community resources play an important role in patients' health and affects readmission within 30-days of initial discharge.

This study selected two areas within the state of North Carolina, Durham County an area rich in community and health care resources and Granville County an area with limited resources, to conduct an analysis of patient encounters and readmission after discharge in two hospitals DUH and DRH in a 10 year period. When individual- and area-level factors were included in the analysis, it showed that Granville County patients were more likely to be readmitted to the hospital within 30-days of discharge.

From a public health perspective it is important to conduct studies such as this one to assess the effect of community support, to validate the interventions already in place in the community, and to give public health professionals the appropriate tools to propose changes at a hospital, community and policy level.

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Table 1. Durham and Granville Counties by Economic Indicators and Zip Code

	Population count (#)	Percent Age 65 + (%)	Percent white (%)	Percent Black (%)	Percent Hispanic (%)	Median HH income ($$)	Percent No health insurance (%)	Percent Below poverty level (%)
Durham	267,587	9.80	46.40	38.00	13.50	51,853	16.40	18.50
27701	21,228	7.50	33.40	49.40	20.70	26,690	27.50	33.60
27703	41,937	7.20	32.10	51.90	17.60	54,767	19.10	20.30
27704	34,517	10.30	30.90	53.90	17.00	41,091	17.70	22.00
27705	46,282	11.70	61.30	19.20	14.20	46,597	9.80	19.30
27707	45,023	9.60	41.30	42.10	15.90	45,831	20.00	23.40
Granville	59,916	12.40	60.40	32.80	7.50	49,852	13.10	15.40
27507	1,929	15.30	68.60	26.20	4.10	47533	16.60	11.40
27509	10,167	9.30	45.00	45.80	12.50	42169	12.80	21.60
27522	12,335	10.70	69.10	23.60	8.30	52468	13.10	10.10
27565	25,255	16.00	51.90	41.80	6.20	43507	13.90	19.50
27581	3,049	11.00	83.20	11.50	4.20	52560	14.90	11.50
27582	289	22.10	37.70	61.90	0.70	55000	35.40	3.80

Source: 2015 ACS Census Data

Table 2. Durham and Granville Counties Health Care Resources within 10 miles of Zip Code

Durham	0-10 miles
27701	Health Care for the Homeless Early Intervention Clinic Holton Clinic Lincoln Community Health Center Lyon Park Clinic Walltown Clinic Durham Center Access Live Well N Durham Medical Park John H. Lucas Sr Wellness Center IFC Community Health Center
27703	Holton Clinic Lincoln Community Health Center Health Care for the Homeless Early Intervention Clinic John H. Lucas Sr Wellness Center Lyon Park Clinic Walltown Clinic Durham Center Access Live Well N. Durham Medical Park
27704	Holton Clinic Live Well N. Durham Medical Park Durham Center Access Health Care for the Homeless Early Intervention Clinic Walltown Clinic Lincoln Community Health Center Lyon Park Clinic John H. Lucas Sr Wellness Center
27705	Walltown Clinic Lyon Park Clinic Durham Center Access Live Well N Durham Medical Park Early Intervention Clinic Health Care for the Homeless Lincoln Community Health Center Holton Clinic IFC Community Health Center John H. Lucas Sr Wellness Center Carrboro Community Health Center Piedmont Health Services
27707	John H. Lucas Sr Wellness Center Lyon Park Clinic Lincoln Community Health Center Early Intervention Clinic Health Care for the Homeless Walltown Clinic Holton Clinic IFC Community Health Center Durham Center Access Carrboro Community Health Center Piedmont Health Services Live Well N Durham Medical Park
Granville	**0-10 miles**
27507	N/A
27509	N/A
27522	N/A
27565	Rural Health Group Rural Health Group at Henderson
27581	N/A
27582	N/A

Table 3. DEDUCE Cohort Filter

Description	Data Element	Definition
Patient Demographics	Duke Medical Record Number	Unique identifier of a specific patient visit
	Patient Date of Birth	The date upon which the patient was born
	Patient Gender	The patient's gender
	Patient Race	The patient's race
	Patient Ethnic Group	The field that captures whether the patient self-identifies as Hispanic or Latino
	Patient Death Indicator	An indicator that the patient is deceased and from where the information was collected
Patient Geography	Patient's city	The city in which the patient has an address
	Patient Primary Postal Code	The primary postal code in which the patient has an address
	Patient County	The county in which the patient has an address
Patient Hospital Encounters	Hospital	The hospital where the encounter took place
	Admit Date	The date the patient was admitted to the hospital
	Discharge Date	The date the patient was discharged from the hospital
	Payor Group	The category group for the primary payor for this encounter
	Patient Age at Arrival in years	The age of the patient at arrival, in years
	MS DRG Code	
	ICD9 Diagnosis Code	The code that represents the diagnosis in the international classification coding system
	Diagnosis Name	The name of the diagnosis
	Diagnosis Date	The date the diagnosis was made by a clinician or coded
	Diagnosis Type Description	The type of diagnosis

Table 4. Durham and Granville Counties CVD Patients Individual and Area Level Characteristics

	Total† (n = 3,143)	Durham (n = 2,873)	Granville (n = 270)	*P* Value
Number of patients	1,033	926 89.64%	107 10.36%	
Individual-level Characteristics				
Age	75.87 (13.05)	76.58 (12.66)	68.27 (14.68)	<.001
Male (%)	38.69	37.52	51.11	<.001
Non-white race (%)	57.05	60.39	21.48	<.001
Admission hospital (%)				
Duke University Hospital (DUH) (%)	54.18	55.48	40.37	<.001
Duke Regional Hospital (DRH) (%)	45.82	44.52	59.63	<.001
Area-Level Characteristics ‡				
Percent elderly (age 65+)	10.22 (1.68)	10.02 (1.38)	12.33 (2.78)	<.001
Percent Non-white race	56.16 (13.02)	57.62 (12.15)	40.65 (11.84)	<.001
Percent with no health insurance	17.19 (5.41)	17.54 (5.53)	13.46 (0.60)	<.001
Percent below poverty level	22.48 (4.83)	23.10 (4.31)	15.81 (5.00)	<.001
Household income (in thousands, $)	42.92 (6.69)	42.52 (6.70)	47.27 (4.73)	<.001
30-Day readmission (%)	18.20	18.17	18.52	.887

Note: Values reported as percentages for categorical variables and mean (standard deviation) for continuous variables.
† Study n's represent number of hospital encounters.
‡ Measures obtained from 2010 Census data.

TABLE 5. Analysis for factors associated with Cardiovascular disease patients, 30-day readmission in Durham and Granville Counties

	Odds Ratio (95% CI)		
	Model 1	**Model 2**	**Model 3**
Granville county (vs. Durham)	1.02 (0.88-1.19)	1.09 (0.96-1.24)	1.28(1.47-1.43)
Individual-level Characteristics			
Age		1.01 (1.01-1.01)	1.01 (1.00-1.01)
Male		1.14 (1.12-1.15)	1.14 (1.13-1.15)
Non-white race		1.10 (1.00-1.21)	0.98 (0.96-1.00)
Area-Level Characteristics			
Percent Non-white race			1.01(1.00-1.02)
Household income (in thousands, $)			0.99 (0.99-0.99)

Abbreviations: CI, confidence interval.
Note: All models adjust for clustering by admission hospital.

Figure 1. Durham and Granville Counties selected zip codes area

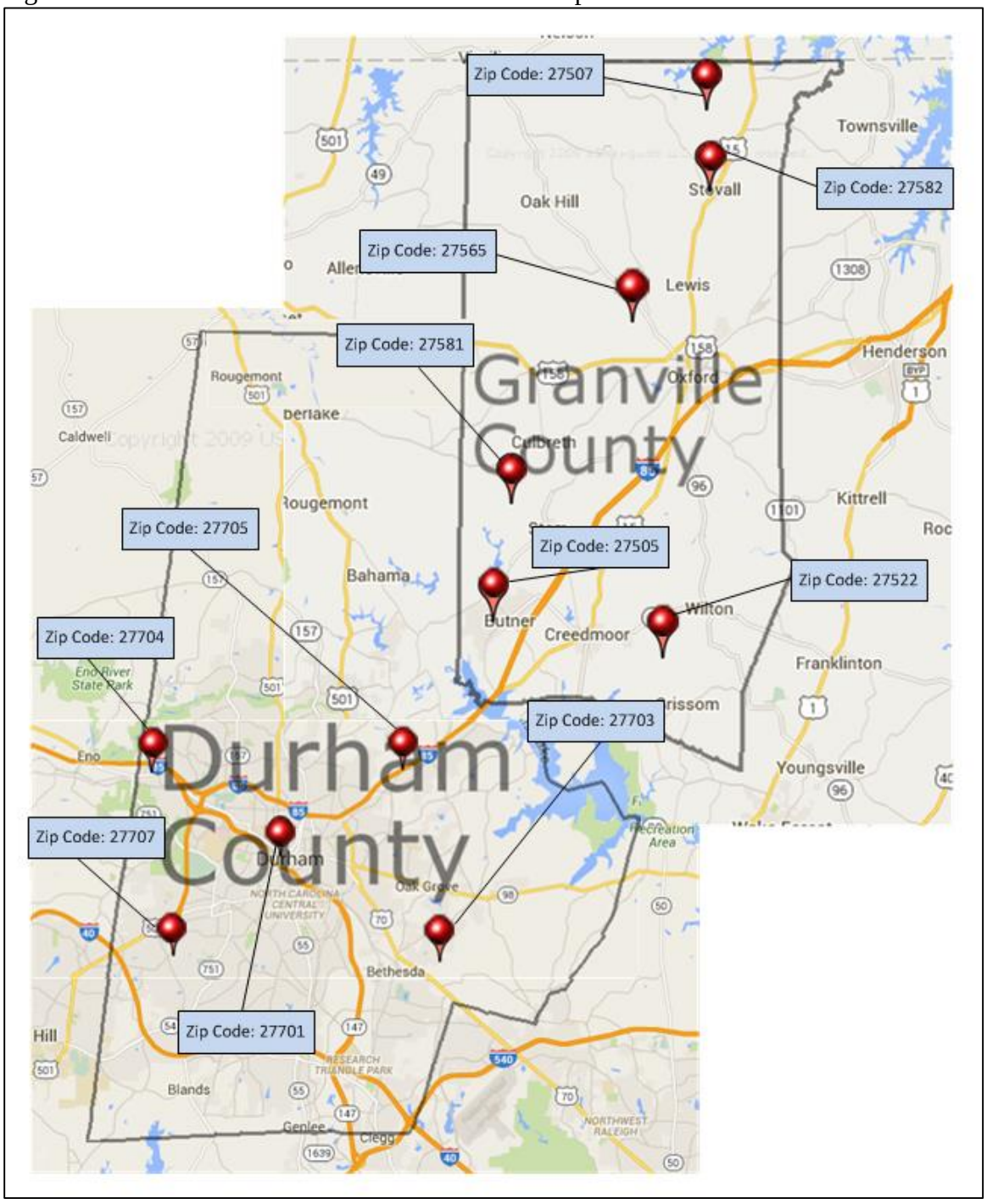
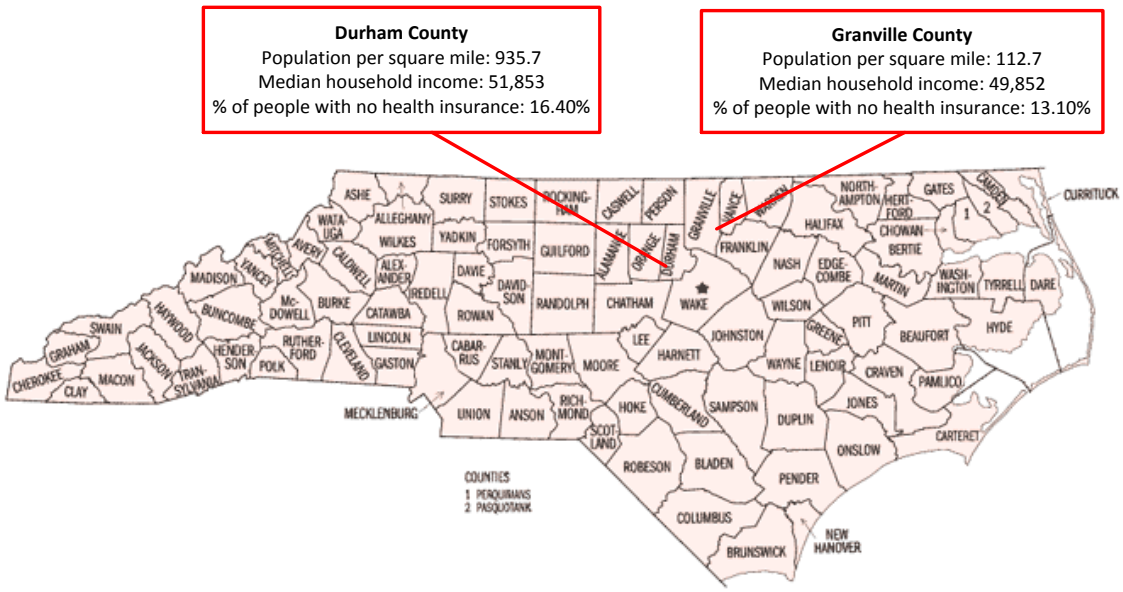


Figure 2. Durham and Granville County comparison



United States Census Bureau. (2015).